Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2000

Investigation of Wolf Population Response to Intensive Trapping in the Presence of High Ungulate Biomass

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Research Performance Report
1 July 1999–30 June 2000
Federal Aid in Wildlife Restoration
Grant W-27-3, Study 14.17

This is a progress report on continuing research. Information may be refined at a later date.

RESEARCH PERFORMANCE REPORT

STATE: Alaska **STUDY:** 14.17

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GRANT: W-27-3

STUDY TITLE: Investigation of Wolf Population Response to Intensive Trapping in the Presence of High Ungulate Biomass

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PERIOD: 1 July 1999–30 June 2000

SUMMARY

Since 1954 the wolf (*Canis lupus*) population in Unit 20A has been reduced 3 times by government wolf control programs and has continuously sustained annual harvests by the public under liberal hunting and trapping regulations. The latest wolf control program ended in December 1994. We initiated this study in March 1995 to document the effects of wolf control on wolf population dynamics and to monitor the wolf population's recovery in the presence of high ungulate biomass and moderate harvest by public hunters and trappers.

We captured and marked 9 wolves between 1 October 1999 and 1 April 2000. During the period 1 July 1999–30 June 2000, we recorded 408 wolf locations and 209 pack locations during 39 days of telemetry flights totaling approximately 150 flight hours. We also searched after fresh snow for unmarked packs in late March and early April 2000. In approximately 30 flight hours of wolf surveys we detected 1 additional pair of wolves within the study area that was not associated with radiocollared wolves.

The 1 November 1999 wolf population within the 11,750-km^2 study area contained 100 wolves in 16 radiocollared wolf packs. One additional collared wolf was not associated with a pack, bringing the minimum known population size to 101 wolves (8.6 wolves/1000 km^2). That estimate is 36% below the 1998 autumn estimate of 158 wolves (13.4 wolves/1000 km^2). Harvest by hunters and trappers was the greatest mortality factor accounting for 22 of 25 collared wolves (88%) that died within the study during the period 1 July 1998–30 June 1999. Preliminary harvest records indicated hunters and trappers took at least 41 wolves from study packs during winter 1998–1999, an exploitation rate of 26%. Additional population losses occurred from dispersal and natural mortality.

Between 1 July 1999 and 30 June 2000, 7 radiocollared wolves died within the study area. Hunters and trappers killed 5 of the 7 (71%), 1 wolf starved after being attacked by other

wolves, and 1 male older than 10 years died of unknown causes. We conducted postmortem examinations on 25 wolf carcasses purchased from hunters and trappers.

Key words: litter size, postmortem examination, pregnancy rates, trapping, wolf control, wolves.

CONTENTS

BACKGROUND

Gasaway et al. (1983) documented the early history of wolf (*Canis lupus*) control in Unit 20A; a brief summary follows. Between 1954 and 1960 the Unit 20A wolf population was reduced by poisoning and aerial shooting to a density of approximately 4 wolves/1000 km^2. After wolf control ended in 1960, wolves increased and by 1970 had attained densities of 16 wolves/1000 km^2. Moose (*Alces alces*) increased to high densities (≥1300 moose/1000 km^2) by the mid-1960s, then declined to a low density (165 moose/1000 km^2) by 1975. Between 1976 and 1979, wolves were again reduced by aerial shooting to a density of 3 wolves/1000 km^2. Moose, caribou (*Rangifer tarandus*), and wolf populations all increased during the 1980s and wolves reached a density of 16 wolves/1000 km^2 by autumn 1991 (Boertje et al. 1996). Wolves were reduced during a third government wolf control program during winters 1993–1994 and 1994–1995.

Wolf populations recovered rapidly in Unit 20A following wolf control in the 1950s and 1970s. High rates of recovery imply a high level of productivity and/or immigration among the recovering wolf populations. Rausch (1967) observed high pregnancy rates among wolf populations subjected to wolf control, and others have suggested that exploitation of wolf populations causes a deterioration in natural, social restrictions to breeding (Woolpy 1968; cited by Packard and Mech 1980). If social restrictions on breeding are significant, the proportion of pregnant females in unexploited populations should be lower than among highly exploited populations.

Harvests of 15–40% (Gasaway et al. 1983; Ballard et al. 1987; Fuller 1989) have stabilized wolf populations, but the mechanisms by which unexploited or lightly exploited populations are regulated are not always clear. Packard and Mech (1980) reviewed the concept of "intrinsic limitation" and found it inadequate to explain wolf population regulation in many cases. While social factors may buffer changes in wolf population response to changes in prey populations (Packard et al. 1983), nutrition probably has the greatest ultimate influence on population regulation in unexploited and lightly exploited wolf populations. Changes in prey vulnerability, time lags in the numerical response to changes in nutrition (Packard and Mech 1980), and varying rates of exploitation by humans contribute to difficulties in deciphering the influence of intrinsic social mechanisms.

The most recent wolf control program in Unit 20A (1993–1994) was conducted to halt a precipitous decline in caribou numbers that occurred during a series of severe winters (Boertje et al. 1996). However, the moose population did not significantly decline during those winters, and moose population density is now approximately 675 moose/1000 km^2. After wolf control ended, caribou numbers stabilized. Consequently, the reduced wolf population is recovering in the presence of relatively high prey numbers. Based on regressions of ungulate biomass versus wolf density from study areas throughout North America (Fuller 1989; Messier 1995), the ungulate prey base in Unit 20A could support a wolf density of 20–25 wolves/1000 km^2. Those densities are 25–56% higher than previously recorded in Interior Alaska (Boertje et al. 1996). Therefore, if social limitation is of major importance (Haber 1996) in limiting wolf population size, it should have ample opportunity to express itself in the Unit 20A wolf population. If wolves do stabilize at moderate densities,

we have a rare opportunity to examine the potential for an ungulate–wolf equilibrium where wolves are socially regulated before they become food limited and ungulates remain at high density.

The history of periodic intense wolf harvest in Unit 20A caused redistribution of pack territories and may have affected reproductive success of surviving females. In contrast, within the adjacent Denali National Park, legal harvest of wolves has been prohibited since 1952. On lands added to the park by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, subsistence users and sport hunters occasionally harvested wolves, but harvests were very low. Apparently, humans have harvested only 3 wolves within the entire 14,200 km^2 Denali Park and Preserve Conservation Unit between 1986 and 1992 (Meir et al. 1995).

The genetic relatedness (Lehman et al. 1992), social structure, natural mortality, dispersal, reproductive characteristics (Meir et al. 1995), and predation characteristics (Adams et al. 1995; Mech et al. 1995; Mech et al. 1998) of the unexploited Denali wolf population have been well documented. National Park Service biologists continued to monitor approximately 10 radiocollared packs within the park and preserve between 1992 and 1996 (B Dale, personal communication).

This report documents progress made during fieldwork conducted between 1 July 1999 through 30 June 2000.

STUDY OBJECTIVES

1 Document the effects of intensive trapping on wolf pack structure and viability based on breeding characteristics and productivity, ages and rates of dispersal, causes and rates of natural mortality, and spatial distribution of individuals and packs.

2 Evaluate those effects relative to current wolf harvest management practices in consideration of public concerns regarding the potential for long-term ill-effects arising from human exploitation of wolves.

JOB OBJECTIVES

Procedures for the proposed objectives are listed with each objective.

1 Compile results of ground-based wolf control conducted by intensive trapping in Unit 20A. Existing records contain data on composition of the harvest, geographical distribution of the harvest, distribution of harvest among packs, efficacy of the trapping effort, estimates of population size, and reproductive performance of the precontrol wolf population. These data will be compiled to serve as a basis for comparison to data collected during wolf population recovery.

2 During each year of the study, maintain a sample of at least 40 radiocollared wolves comprising at least 30 females in at least 10 packs that currently exist or arise within the core wolf control area. Radiomarked packs will be captured at least once each year

to place radio collars on adult female wolves and to apply earmarks to juvenile females so that a known-aged sample of females is maintained within the population.

3 Determine pregnancy rates and fetal litter sizes using ultrasound scanning in early April each year. Radiocollared adult females (age ≥22 months) will be recaptured approximately 20–30 days following the end of the breeding season to determine frequency of pregnancy and in utero litter size. Other adult females that are not radiocollared but associated with the pack will also be captured and added to the collared sample of adult females.

4 Determine movements, dispersal activities, and denning locations of known pregnant females during the last half of pregnancy and during the first 2 weeks following the estimated parturition date for each female. Females that are known to be pregnant based on ultrasound results will be located approximately 3 times each week between early April and mid-June. Parturition dates will be estimated based upon dates of den entrance.

5 Determine oversummer wolf pup survival. Selected dens will be monitored beginning 3 weeks after parturition to estimate litter sizes at birth. Dens will be viewed from the ground using spotting scopes. Late summer estimates of pup survival will be based on aerial observations of wolves at summer rendezvous sites or aerial observations of traveling packs during late September and early October.

6 Determine annual wolf population estimates during autumn and spring. Population estimates will be based on the maximum number of wolves seen in radiocollared wolf packs during early autumn and additional wolves detected during aerial surveys that are not associated with packs. Fixed-wing aerial surveys will be conducted 2–5 days after a fresh snowfall during the autumn period (Oct–Nov) and during the spring period (Mar–Apr) to search for unmarked wolf packs.

7 Determine wolf pack territory size based on a minimum of 40 locations per wolf pack per year. During each month of the year, radiotracking flights will be conducted to determine wolf pack movements and annual home range size.

8 Cooperate with studies on moose and caribou to maintain accurate estimates of moose and caribou population size and distribution over time and relative to changes in wolf density. Periodic assistance will be provided to caribou and moose research programs to ensure that prey distribution data are regularly collected. We will conduct monthly caribou radiotracking and autumn moose distribution flights.

9 Investigate and determine the causes of wolf mortality. A helicopter will be used to visit sites where wolf mortality signals are detected. Remains of wolf carcasses will be collected and analyzed for cause of death when cause is not apparent from on-site evidence.

10 Determine sex and age of wolves taken by public trappers and hunters within the study area. The vulnerability of various sex and age classes to hunting and trapping

will be determined by comparing the sex and age of the harvest with population sex and age composition estimated from radiolocation and capture data.

11 Conduct literature review. References to canid dispersal, mortality, reproductive success, and predator–prey relationships will be reviewed and incorporated into design of data analysis.

12 Analyze data and prepare figures and text for publication and oral presentations.

13 Write annual progress reports and a final report at the end of the study period.

STUDY AREA

The study area lies within Unit 20A (17,601 km^2) of Interior Alaska. Elevations within the study area range from 110 to 4000 m, but most wolves and their prey are at elevations below 2000 m. As the terrain slopes upward from north to south, the habitat changes from poorly drained "flats" of boreal spruce forest underlain by permafrost through a zone of alpine shrubs and into an alpine community of grasses, sedges, and forbs. Elevations above 2000 m are often covered by permanent snow or glacial ice.

Wolves prey primarily on moose, caribou, and Dall sheep (*Ovis dalli*). A small herd of approximately 400 bison (*Bison bison*) occupy grass/sedge meadows along the eastern edge of the study area in summer and autumn. Bison are available as prey for only 1 wolf pack within the study area. Wolves also prey on beavers (*Castor canadensis*), snowshoe hares (*Lepus americanus*), and ground squirrels (*Spermophilus undulatus*). Beavers are common in the drainages along the foothills of the Alaska Range. Snowshoe hare numbers increased during the study period as hares approached the high of their 10-year cycle. Other potential ungulate predators include black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), coyotes (*Canis latrans*), wolverine (*Gulo gulo*), and lynx (*Felis lynx*). Golden eagles (*Aquila chrysaetos*) also prey on newborn caribou and Dall sheep.

The area is roadless except for seasonal mining trails and trails to homestead sites along the western boundary of the area. Two families occupy permanent homestead sites in the center of the study area. The community complexes of Healy/McKinley Park and Delta Junction/Fort Greely lie outside the western and eastern boundaries, respectively. Denali National Park lies adjacent to the study area to the west. Access to the study area is by air via numerous airstrips associated with mining or guiding, or unimproved landing sites along streams and ridges.

METHODS

COMPILING RESULTS OF GROUND-BASED WOLF CONTROL

Job 1

We previously documented Unit 20A estimated wolf population size and harvest during the first year (1993–1994) of ground-based wolf control (McNay 1999). During the current

reporting period, we compiled the results of the 1994–1995 wolf control program and wrote a narrative detailing 1993–1995 pack histories (Appendix A). The wolf population estimate for winter 1994–1995 was based upon sightings of unmarked wolf packs, counts from wolf packs that were radiocollared as a part of this study in March 1995, and from a tally of animals harvested by both state and private trappers between October and April.

ESTIMATING WOLF POPULATION SIZE AND HARVEST

Job 6

Beginning in November 1996, wolf population estimates were based on wolves associated with radiocollared wolves, plus harvested animals not associated with collared packs. When noncollared packs or single wolves were observed, they were included in population estimates. Where possible, each harvested wolf was assigned a pack affiliation based on the location of take and upon harvest chronology. We used harvest chronology by comparing the date and location of harvest for each wolf with previous and subsequent counts of the wolf pack associated with each harvest location.

During winters 1993–1994 and 1994–1995, we estimated the entire Unit 20A wolf population based on counts made during wolf control activities and upon wolves harvested during wolf control (McNay 1999). Beginning with the autumn 1996 estimate, the wolf population was estimated only for the study area portion of Unit 20A defined by plotting a 95% Kernel home range around all radiolocations of nondispersing collared wolves within Unit 20A. Defined in that manner, the study area contained only the home ranges of radiocollared wolf packs that were intensively monitored during the period March 1995–June 2000. The study area did not contain the northern portion of the Tanana Flats nor the range of the Wells Creek pack in Unit 13E.

During the current reporting period, we searched for unmarked wolf packs in March and early April. On each survey day we also located and counted individuals in marked packs so we could confidently separate marked (i.e., radiocollared) packs from unmarked packs. We searched primarily in areas between known home ranges of collared packs and followed fresh wolf tracks in snow until we saw the wolves.

WOLF CAPTURE AND HANDLING

Jobs 2, 3, 4, 6, and 7

We darted wolves from helicopters, using 3cc Palmer Cap-Chur darts loaded with 500–560 mg of Telazol® and propelled by low-velocity (brown) charges. Wolves were either eartagged or fitted with radio collars containing a mortality-sensing device (Telonics, Inc. Mesa, Arizona USA).

WOLF TELEMETRY LOCATIONS

Jobs 4, 5, 6, 7, and 9

We conducted radiotracking flights from fixed-wing aircraft throughout the reporting period. For each observation we recorded location, pack size, color composition, cover type, activity, and weather information.

PUP PRODUCTION AND SURVIVAL

Jobs 2 through 5

During May and June 2000, we conducted radiotracking flights at roughly 10-day intervals to identify den sites of study packs, but we did not fly intensively to estimate dates of den entry. During late summer 1999 from fixed-wing aircraft, we estimated summer litter sizes when wolves moved their pups to rendezvous sites. Autumn pup counts were made during telemetry flights in late September through early November when pups were traveling with packs. Pups were identified from the air, based on their size, behavior, pelage quality, and stamina.

KILL RATES AND COMPOSITION OF PREY

Jobs 2, 4, 6 and 8

During winter 1999–2000, we developed and submitted a proposal to continue the study on kill rates (Appendix B). The study entitled, " Predation on moose and caribou by a regulated wolf population" will be conducted during winter 2000–2001.

MORTALITY AND POSTMORTEM EXAMINATIONS

Jobs 9 and 10

We purchased wolf carcasses from private trappers. During postmortem examinations we recorded location, method and date of take, and body measurements. Female reproductive tracts were removed and dissected. We counted placental scars, excised and weighed xiphoid fat, collected tissue and noted injuries. Skulls were cleaned and an upper premolar was extracted for cementum aging from animals more than 1 year of age. First year animals were aged on evidence of incomplete epiphysal closure in the radius and ulna. When possible we assigned a pack affiliation to each harvested wolf.

RESULTS AND DISCUSSION

COMPILING RESULTS OF GROUND-BASED WOLF CONTROL

Job 1

See Appendix A.

ESTIMATING WOLF POPULATION SIZE AND HARVEST

Jobs 1 and 6

The 1 November 1999 wolf population was estimated at 101 wolves in 16 packs within the 11,750 km^2 intensive study area (8.6 wolves/1000 km^2) (Table 1). All 16 packs contained radiocollared wolves in autumn, but 1 unmarked pair was sighted during a wolf survey in April 2000. The population estimate for autumn 1999 was 36% below the 1998 estimate. Preliminary harvest records indicated hunters and trappers took at least 41 wolves from study packs during winter 1998–1999, an exploitation rate of 26%. Additional population losses apparently occurred from dispersal and natural mortality.

WOLF CAPTURE AND HANDLING

Jobs 2, 3, 4, 6, and 7

We captured 9 wolves from 5 packs during October 1999 and March 2000. Among the 254 captures completed during this study since March 1995, 5 wolves (2%) have died as a result of capture. Two died from darts wounds, 2 choked on regurgitated food, and 1 suffocated in deep snow. A hunter shot 2 additional wolves during the night following their capture in March 1997, and we suspect those wolves, although probably standing, had not fully recovered from the effects of immobilization.

WOLF TELEMETRY LOCATIONS

Jobs 4, 5, 6, 7 and 9

During the period 1 July 1999–30 June 2000, we recorded 408 wolf locations and 209 pack locations during 39 days of telemetry flights totaling approximately 150 flight hours. Those included flights associated with kill rate studies, capture, den-site monitoring, and general telemetry flights. Data from those flights have been entered into various databases for further analysis.

PUP PRODUCTION AND SURVIVAL

Jobs 2 through 5

Thirteen of 17 adult females scanned with ultrasound in April 1999 were pregnant. The total sample contained 5 dominant females in established packs, 5 females of new pairs, 6 subordinate females in established packs, and 1 dispersing subordinate female. Among the 4 females that were not pregnant, 3 were subordinates in established packs and the fourth was a lone dispersing female.

Of the 13 pregnant females, 1 died before parturition. Among the remaining 12, 7 produced litters that survived until late summer 1999. Among the 5 pregnant females that did not produce surviving litters, 3 either never appeared at dens or did not remain at suspected den sites for more than a few days. The other 2 probably did produce pups. The first, female nr. 323 established a den within her pack's home range—several miles from that of the alpha female. We visited her den in mid-May 1999 and confirmed the presence of at least 3 pups. However, the female abandoned the den by late May and the pups did not survive. The second

female (nr. 355), part of a newly formed pair, possibly produced a litter of pups because she remained at the den for almost 2 weeks. She abandoned the den shortly after other wolves killed her mate in mid-May. We visited the den site but found no evidence of pups.

Among the 5 known pregnant females that did not produce surviving pups, 3 were first time breeders in pairs, 1 had only 3 legs and was a first-time breeder in a trio of wolves, and 1 was a 36-month-old subordinate in an established pack. Among the 7 females that produced surviving pups, 4 were alpha females in established packs, 2 were first-time breeders in new pairs, and 1 was a first-time breeder in an established pack.

KILL RATES AND COMPOSITION OF PREY

Jobs 2, 4, 6, and 8

See Appendix B.

MORTALITY AND POSTMORTEM EXAMINATION

Jobs 9 and 10

Seven radiocollared wolves died during the reporting period within the study area: 5 were killed by hunters and trappers, 1 starved after being attacked and wounded by other wolves, and cause of death was not determined for a male older than 10 years, but we suspected natural causes. The female that starved after being attacked by wolves had been scanned by ultrasound in April 1999. The ultrasound fetal count of 5 matched the placental scars observed during the postmortem examination.

During winter 1999–2000, 25 wolf carcasses were purchased from trappers and hunters. Of those 15 were pups. One of the adult females killed by trappers had been scanned by ultrasound the previous spring. However, she was killed in March at the peak of estrus. During estrus the enlarged uterine lining obscures previous scars of pregnancy; therefore, we could not compare placental scars with the ultrasound scan.

CONCLUSIONS AND RECOMMENDATIONS

The wolf population in the foothills of Unit 20A declined by an estimated 36% between November 1998 and November 1999. Hunting and trapping were the primary sources of mortality within the study population, accounting for 88% of the mortality among collared wolves during the period 1 July 1998–30 June 1999 and 71% of the mortality among collared wolves during the period 1 July 1999–30 June 2000. Pups composed 44% of the estimated 1998 November population but only 36% of the autumn 1999 study area population.

ACKNOWLEDGMENTS

Cathie Harms, Tony Hollis, and Laura McCarthy assisted in collection of field or necropsy data. Laura McCarthy provided editorial expertise for this progress report. Pilots Dennis Miller, Rick Swisher and Marty Webb flew helicopter or fixed surveys and provided logistical support for several aspects of this project.

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Table 1 Estimated pack size and number of autumn pups among radiocollared wolf packs in Unit 20A, November 1998 and November 1999

	Estimated autumn pack size		Estimated autumn pups	
Pack name	1998	1999	1998	1999
West Fork	15	13	6	4
Yanert	7	3	2	0
Jumbo	15	0	5	0
Dry Creek	9	0	5	0
100-Mile	19	7	12	3
Dry Flat	14	12	8	5
Lignite	7	9	2	4
Tatlanika	14	8	6	3
Ptarmigan	7	8	4	5
Moose Creek	12	5	5	0
Buzzard Creek	5	7	3	2
Slide Creek	2	0	0	0
Rockstadt	3	2	0	0
Sheep Creek	0	7	0	5
Paradise	8	0	3	0
Boulder	14	7	9	3
3-Mile	2	0	0	0
Rogers	0	2	0	0
Bonnifield	0	2	0	0
Rex	0	5	0	3
Kobe	0	3	0	0
Single wolves	5	1		
Totals	158	101	70	37

APPENDIX A Pack histories of wolf packs in Unit 20A subjected to wolf control during October 1993–April 1995

PACK HISTORY OF WOLF PACKS IN UNIT 20A
OCTOBER 1993–APRIL 1995

CODY PACK

The Cody Creek pack occupied the upper Wood River drainage and centered their activities near the mouth of Cody Creek during winter 1993–1994. Seven grays were seen in mid-October and in late October a track of more than 6 wolves traveled to a trap site near the mouth of Cody Creek where 2 wolves were caught. By 15 November, state trappers had taken 5 grays from that single trap site near Cody Creek. In early January tracks indicated that 3 wolves remained in the upper Wood River, suggesting the autumn pack was at least 8. A private trapper took 1 additional wolf in February and the spring pack size was estimated to be 2 wolves. The harvest from this pack consisted of 3 pups, 1 yearling female, and a 4-year-old female that had not produced pups the previous year (i.e., no placental scars). The sixth harvested wolf was eaten in the snare by other wolves, and its sex and age was undetermined. Therefore, at least 1 of the alpha pair, if not both, survived until late spring.

In October 1994, tracks of up to 6 wolves were seen in the vicinity of Cody Creek, but a maximum of 4 wolves were sighted on 2 occasions in late October and early November. Department trappers killed 3 pups in snares during late November and early December. A lone wolf was sighted in Big Grizzly creek in mid-December, probably the last wolf in this pack. Clearly the pack had reproduced, but at least one of the dominant animals died or dispersed away from the pack during summer/early fall 1994.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	8 gray	5 gray
Spring pack size and color composition	2 gray	1 gray
Wolves killed by state trappers	5 gray	3 gray
Wolves killed by private trappers and hunters	1 gray	0
Total harvest	6 gray	3 gray

YANERT PACK

The Yanert pack ranged throughout the Yanert River drainage, the Moody Creek drainage, and occasionally ventured into the Healy Creek and Carlo Creek drainages. Moose densities in the Yanert River drainage were lower than in other areas of Unit 20A, but caribou were seasonally abundant.

The National Park Service radiocollared on the alpha male of the Yanert pack in March 1991, when the pack contained 10 wolves. Harvest records indicated 9 wolves were shot from this pack before the collar was deployed, therefore autumn pack size was at least 19 wolves. In February 1993, department biologists saw 24 wolves in the Yanert pack pursuing caribou near Louis Creek. In October 1993 the pack numbered a minimum of 27 wolves based on a sighting of 23 wolves after 4 had been shot by state trappers.

During winter 1993–1994, 4 wolves were shot from the ground, state trappers snared 2 wolves, and private trappers took a total of 10 wolves from the Yanert territory. The spring 1994 pack size estimate of 11 wolves was based on the estimated autumn pack size minus the known harvest of 16 wolves. Among the harvested wolves there were 7 pups, 3 yearlings, 2 adults and 4 of unknown age. The adults included the 4-year-old alpha male that was wearing the radio collar deployed by the Park Service, and a 2-year-old female that had 4 placental scars indicating pregnancy during spring 1993.

In September 1994, 2 nonresident hunters reported stalking a pack of 15 grays in Moose Creek. They reported 12 pups and 3 adults, and shot 1 of the pups and an adult female. A month later in October, department trappers saw 19 grays in the Yanert. In addition to the 2 wolves taken by the nonresident hunters, department trappers killed 12 wolves from the Yanert pack between October and early March. Among the 14 wolves killed during winter 1994–1995 there were 11 pups, 1 yearling male, one 3-year-old female, and 1 reported as an adult female by the nonresident hunters. The reproductive tract of the 3-year female did not contain placental scars. The age and reproductive history of the adult female killed by the hunters was unknown.

In March 1995, department biologists darted and marked 5 Yanert wolves, 4 pups and the alpha female. At that time biologists counted 11 wolves remaining in the pack. Therefore, the original autumn 1994 population contained at least 15 pups, 1 yearling male, 3 adult females, and 6 wolves of unknown sex and age. The pup component of the 1994 pack represented at least 2, possibly 3, litters. Based on the large pack sizes and rapid recovery to preharvest numbers, the Yanert pack probably produced multiple litters in 1990, 1991, 1992, 1993, and 1994.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	27 gray	25 gray
Spring pack size and color composition	11 gray	11 gray
Wolves killed by state trappers	6 gray	12 gray
Wolves killed by private trappers and hunters	10 gray	2 gray
Total harvest	16 gray	14 gray

RAINBOW LAKE PACK

The home range of the Rainbow pack included portions of military restricted area R-2202. Over flights of R-2202 were generally prohibited and state wolf control activities were excluded from all military lands within and surrounding the restricted area. Therefore

estimates of pack size came from track counts outside of military lands and from harvests reported by private trappers trapping on military lands.

On 13 March 1994 state trappers followed the track of 8 wolves for 10 miles along the Tanana River near Rainbow Lake. Prior to that track sighting, private trappers had taken 9 wolves from the Rainbow lake area, suggesting the original autumn pack size was at least 17 wolves. Of the 9 harvested wolves, 5 were black and 3 were gray. The harvest was reported from the Delta River, lower 100-Mile creek, and lower Delta Creek indicating that some of those wolves could have been members of the 100-mile pack whose range encompassed the upper portions of 100-Mile Creek. However, observations and harvest from the 100-Mile pack during winters 1993 and 1994 never included black wolves. None of the carcasses of wolves killed from the Rainbow pack were obtained for post mortem examination; therefore the age composition of wolves killed from the pack was unknown.

The pack apparently remained intact over summer and produced pups. On October 25, 1994 biologists saw a pack of 11, (7gray and 4 black) traveling near Delta Creek. At that time they estimated 7 of the 11 were pups. The same day the 100-Mile pack of 12 grays was seen only 4 miles from the sighting of the Rainbow pack.

Three wolves from the Rainbow pack, 2 black and 1 gray, were legally killed by a private trapper during winter 1994–1995. None of the carcasses were examined by department biologists and the age composition of the harvest was unknown. Biologists live-captured and radiocollared 4 wolves in the Rainbow pack in late March 1995. Those captured wolves included 2 male pups and 2 post estrus adult females estimated to be 22 and 34 months old. Both of the collared females were illegally killed in early April and the carcass of the 34-month-old female was recovered. Post mortem examination showed that she was carrying 5 fetuses. Subsequent radiolocations indicated that 5 wolves (1b,4g) survived in the Rainbow pack throughout the summer 1995.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	17 (unk color)	11 (4b,7g)
Spring pack size and color composition	8 (unk color)	5 (1b,4g)
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	9 (5b,4g)	5 (2b,3g)
Total harvest	9 (5b,4g)	5 (2b,3g)

WEST FORK PACK

The West Fork pack originally contained 7 grays that occupied the mountains and foothills between the West Fork of the Little Delta River and Delta Creek. We followed a track of 7 wolves on 4 November 1993 in the Upper East Fork then sighted 3 grays on 8 November in the same area. Two wolves believed to be from the West Fork pack were caught in snares near Buchanan Creek about 20 November and were entirely consumed by other wolves. We believe the wolves were eaten by the Iowa Ridge pack, a pack of 18 grays that occupied an adjacent territory west of Buchanan Creek. We saw the remaining 5 grays of the West Fork pack on 26 November traveling east toward Delta Creek then followed a track of 5 on

30 November that turned west from Delta Creek back toward the East Fork. State trappers saw 5 grays on Buchanan Creek on 14 December and tracked 5 wolves along Buchanan Creek to the upper East Fork on 15 February. The pack remained at 5 at least until early March 1994 when their track was followed to a trap site near Buchanan Creek where a single pup was caught. The last evidence of the pack was on 18 March when state trappers followed a track of 3+ wolves to a recent kill on upper Buchanan Creek.

At least 1 wolf of the breeding pair survived and produced pups during summer 1994. In autumn 1994 the pack numbered at least 8 wolves. In November 1994, state trappers killed 6 grays from the West Fork pack, 5 pups and a yearling. Private trappers did not report taking any wolves from the West Fork pack during both winters 1993–1994 and 1994–1995. The alpha pair apparently survived winter 1994–1995.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	7 gray	8 gray
Spring pack size and color composition	4 gray	2 gray
Wolves killed by state trappers	3 gray	6 gray
Wolves killed by private trappers and hunters	0 gray	0
Total harvest	3 gray	6 gray

MYSTIC PACK

A small pack of 3 wolves ranged along the Wood River north of the Coal Creek during winter 1993–1994. Sightings of this pack were confined to the area along the Wood River between Japan Hills and Mystic Creek. State trappers originally sighted tracks of 3 wolves and saw 1 black in late October near a fresh moose kill at the base of the Japan Hills. On 3 November they saw 1 black and 2 grays in the same area. On 2 other occasions (Jan and Mar) they sighted 1 black and 2 grays near Mystic creek.

The pack was identifiable because 1 of the grays was missing a hind foot. State trappers had snared a wolf by the foot on the Wood River in late November and the wolf chewed off the foot to escape the snare. That 3-legged wolf was seen clearly during March with the black and one other gray near Mystic Creek. On 8 March, state trappers killed a female wolf in the same snare set where the Mystic gray had chewed its leg, but that female wolf appeared to be alone when caught. We suspect that wolf, a 2 yr old, was a disperser and not part of the Mystic Pack of 3.

The Mystic pack produced pups during summer 1994, and the pack numbered 11 wolves in November 1994. State trappers killed 2 pups and a yearling in November and December 1994. No harvested was reported from this pack by private trappers. Three members of the Mystic pack were radiocollared in March 1995 and during subsequent radiotracking flights, we saw the 3-legged gray that was a member of the original pack in 1993.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	3 (1b,2g)	11 (4b,7g)
Spring pack size and color composition	3 (1b,2g)	8 (3b,5g)
Wolves killed by state trappers	0	3 (1b,2g)
Wolves killed by private trappers and hunters	0	0
Total harvest	0	3 (1b,2g)

JUMBO PACK

In 1993, the Jumbo Pack occupied the western foothills between Jumbo, Walker, and Rex Domes. The best sighting occurred on 23 October, when we saw 5 blacks wolves and 1 gray in 1 group, and 2 blacks about 5 miles behind the main group on the same day. However, subsequent harvests and sightings add up to an initial autumn 1993 estimate of 13 wolves; 11 black and 2 gray.

State trappers took the alpha male and 2 pups (all black) on 27 October on Elsie creek. On the same day state trappers shot 2 additional black pups. The next day, 2 black pups were snared near the Liberty Bell Mine, and on 14 November a black and gray pup were snared at the same trap site. A private trapper found a dead black wolf near the Liberty Bell Mine in December, bringing the total mortality before 1 January to 9 blacks and 1 gray.

On 16 February, 2 black and 1 gray were seen near Jumbo Dome after tracking them for more than 20 miles. On 21 March, 2 black and 1 gray were again sighted near the Ferry Trail east of California Creek. No wolves were harvested from this pack after December and we believe the alpha female survived.

On 6 November 1994, a pack of 5 (3 black and 2"blue" wolves) was sighted on Chicken Creek, well within the range of the 1993 Jumbo Pack. On the same day the Steep creek pack of 5 grays and 3 blacks was seen 25 miles to the west, confirming that the 2 packs were separate. We believe the alpha female from the Jumbo pack survived wolf control in 1993, remained in her territory, obtained a new mate and produced pups. State trappers killed 2 pups, a black and a gray, in the Jumbo territory. No harvest was reported by private trappers or hunters.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	13 (11b,2g)	6 (3 black,2blue,1 gray)
Spring pack size and color composition	3 (2b,1g)	4 (2 black,2blue)
Wolves killed by state trappers	9 (8b,1g)	2 (1bl,1g)
Wolves killed by private trappers and hunters	1 black (found dead)	0
Total harvest	10 (9b,1g)	2 (1bl,1g)

100-MILE PACK

Tracks of the 100-Mile pack were seen in the upper portions of the 100-Mile drainage beginning in January 1994. State trappers shot a single gray wolf from a pair at a moose kill on 17 February, and followed a track of 7 wolves for several miles from the same area on

18 March. Private trappers reported taking 2 gray wolves in February and 1 in March within the apparent range of the 100-Mile pack. The trapper who took the wolves in February estimated that 7 remained in the pack. In early April 1994, state trappers saw tracks of 3 wolves on upper 100-Mile creek.

Using the chronology of harvest and track sightings we estimated that in autumn 1993, the 100-Mile pack consisted of 9 gray wolves, 3 were taken in February and 1 in March, leaving a spring 1994 pack size of 5 wolves.

In autumn 1994 the 100-Mile pack of 14 grays was seen on 6 November. The increase in pack size 5 grays in spring 1994 to 14 grays in November, suggested the pack produced multiple litters. During winter 1994–1995, state trappers took 3 pups from the 100-Mile pack. No wolves were reported taken by private trappers.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	9 gray	14 gray
Spring pack size and color composition	5 gray	11 gray
Wolves killed by state trappers	1 gray	3 gray
Wolves killed by private trappers and hunters	3 gray	0
Total harvest	4 gray	3 gray

TATA PACK

When first radiocollared in March 1988, the Tata pack contained 11 grays and 1 black. The pack was monitored during 1989 and consisted of 13 grays, the pack was not followed during 1990, and 1991 but was collared again in March 1992 when it contained 10 grays. In late summer 1993, the pack contained 12 grays.

During winter 1993–1994 the Tata pack was sighted 8 times by department biologists, primarily within the Tatlanika River Drainage, but tracks were also followed north onto the Tanana Flats. Between 30 October and 1 December 1993, 9 Tata wolves were killed by state trappers, including the alpha pair. Spring pack size was estimated by subtracting known harvest from the autumn pack size.

Both adult females that were killed had placental scars indicating they were pregnant during spring 1993. Combined, the 2 females had 13 placental scars, but a maximum of 6 pups survived until October 1993 (i.e., the 3 that were killed by department trappers plus the 3 wolves that survived).

The 3 surviving wolves may have remained within the Tata territory during the summer 1994. On 2 occasions in October 1994, fresh tracks of 2–3 wolves were seen along the Tatlanika River, near the center of the Tata territory. However, in early November the Steep Creek pack occupied the western portion of the old Tata territory and we did not see sign of the possible Tata survivors after that time.

	Regulatory year	
	1993	1994

	Regulatory year	
	1993	1994
Autumn pack size and color composition	12 gray	3 gray
Spring pack size and color composition	3 gray	0
Wolves killed by state trappers	9 gray	0
Wolves killed by private trappers and hunters	0 gray	0
Total harvest	9 gray	0

SNOW MOUNTAIN PACK

Three gray wolves were seen near Snow Mountain Gulch in late October and a week later a gray was caught by state trappers near that location. Then again in late November a second gray was killed at the same snare site and a third gray wolf was seen on 2 consecutive days lying on the ice of the Wood River near the snare site. We believe that third wolf was the last member of the pack and no other evidence of the pack was observed after early December 1993.

Both wolves killed from this pack were 2-year-old females based on cementum age, one had no placental scars, the second had 9 placental scars indicating she had become pregnant during the previous spring at an age of 22 months, the normal age of first breeding for wolves.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	3 gray	0
Spring pack size and color composition	1 gray	0
Wolves killed by state trappers	2 gray	0
Wolves killed by private trappers and hunters	0	0
Total harvest	2 gray	0

SPIRK PACK

This pack of 12 gray wolves occupied the Tanana Flats portion of the Dry Creek drainage south of Blair Lakes and north of Iowa Ridge. State biologists saw 11 grays on 4 November 1993 and followed the track along Dry Creek from near Blair Lakes south to the foothills of the Alaska Range. The wolves were near a fresh moose kill and state trappers set that kill with snares. A week later, 4 wolves were caught at that site and a fifth wolf escaped as the state trappers approached by breaking the snare cable below the lock. A wolf with that type of snare on its neck was taken by a private trapper in December on the Tanana River near the mouth of the Little Delta River and was probably the escaped wolf from the Spirk pack. On 17 November biologists followed a track from the Tanana Flats near Dry Creek into the foothills north of Iowa Ridge and saw 8 grays moving south into the foothills. Three gray wolves were taken a few miles northwest of this sighting on 21 November.

Subsequent harvest and sightings of this pack indicated that only a pair remained in March. State trappers took 9 wolves from this pack and a private trapper took 1. The last evidence of the Spirk pack was seen on 9 March when a pair entered a trap site near the center of the pack's range, 1 wolf was caught in a snare but escaped by pulling out of the snare loop.

Harvest from this pack included 2 adult females that had been pregnant during spring 1993. No adult males were taken and it appeared the alpha male survived.

On 26 October 1994, state trappers saw a track of 7 wolves that traversed the range of the Spirk pack, but those wolves were never sighted and no wolves were reported harvested from the Spirk Pack in 1994. In October 1995, state biologists captured and radiocollared wolves from a pack of 14 that occupied the Spirk territory, but the pack was named the Dry Flat pack. It seems probable that the 7 wolves that occupied the territory in winter 1994–1995 and the 14 that occupied the territory during winter 1995–1996 were the same pack and were descendants of the Spirk pack.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	12 gray	7 unk color
Spring pack size and color composition	2 gray	7 unk color
Wolves killed by state trappers	9 gray	0
Wolves killed by private trappers and hunters	1 gray	0
Total harvest	10 gray	0

PTARMIGAN PACK

A small pack of wolves occupied the Ptarmigan Creek/Delta Creek area within military restricted area R-2205 during winter 1993. A pair of tracks was observed in this area on 13 March, and 3 tracks were observed at an old kill site on 18 March. No harvest was reported from this pack by either state or private trappers.

In autumn 1994, a pair of tracks was again observed near Trident Glacier, but no wolves were seen and no harvest was reported. In October 1995, biologists captured and marked 3 wolves from the Ptarmigan pack. At that time the pack contained the alpha pair and 3 pups. The spring 1995 pack was estimated to contain only the alpha pair.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	3 gray	2 gray
Spring pack size and color composition	3 gray	2 gray
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	0	0
Total harvest	0	0

IOWA RIDGE PACK

The Iowa Ridge pack of 18 grays occupied a territory surrounding Iowa Ridge that included portions of the Dry Creek drainage and both east and west fork drainages of the Little Delta River. The territory was small compared to those of other packs and 4 other packs were identified that overlapped the range of the Iowa Ridge pack. However, in winter 1993, the center of the Iowa Ridge territory contained high numbers of wintering caribou and moose and it seems likely that the apparent restricted movements of the Iowa Ridge pack and the encroachment of neighboring packs reflected the concentration of prey within the center of

this pack's range. In addition, the Iowa Ridge pack was reduced from 18 wolves to a pair of wolves by the end of December; therefore, we had little opportunity to observe movements of the pack that would represent their entire range. Neighboring packs could easily trespass once the Iowa Ridge pack was reduced in both number and social structure.

The pack of 18 grays was first seen on 7 November 1993 on Iowa Ridge. On 27 November, state trappers estimated 8 wolves had left a trap site where 7 wolves from the pack were caught in snares. The pack moved south to another trap site and 3 more wolves were caught. The pack made a moose kill on 13 December near the west fork of the Little Delta River and state trappers stalked and shot the alpha male. Between 13 December and 31 December, 5 more wolves were caught by state trappers near the center of the pack's range and in February a yearling male was caught near a kill the pack had made in the autumn. This represented the last evidence of the Iowa Pack. State trappers killed 17 of the estimated 18 animals in the pack and no harvest was reported by private trappers. Three adult females, ages 6, 7, and 8 were killed in this pack and all had been pregnant during spring 1993. The autumn pack included at least 10 pups, suggesting the pack successful reared at least 2 litters during summer 1993. Only 2 adult males were killed, a yearling and a 5-year old. There was no evidence that this pack existed in autumn 1994. Given the sex and age structure of the wolves killed in 1993–1994, it seems likely that the one surviving animal was a pup or subordinate adult who either died or dispersed.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	18 gray	0
Spring pack size and color composition	1 gray	0
Wolves killed by state trappers	17 gray	0
Wolves killed by private trappers and hunters	0 gray	0
Total harvest	17 gray	0

HEALY PACK

The Healy Creek pack was collared and identified as the "Ewe Creek" pack by the National Park Service (NPS) in 1987. Originally the pack's range included areas west of the Nenana River in Denali Park, but in 1989 the pack's range shifted eastward and their movements centered around the Healy Creek drainage of Unit 20A. The pack consisted of 5 wolves in winter 1991–1992, and 3 wolves in winter 1992–1993. In November 1993, 4 wolves were seen on a moose kill in Coal Creek and a pair of wolves was seen the same day in upper Healy Creek. Assuming all of those wolves were associated, we estimated a pack size of 6 grays in autumn 1993. State trappers caught 3 of those wolves with snares in January 1994. Those snared wolves were eaten in the snares by other wolves so the sex and age of those wolves were unknown. Later that winter a hunter shot a single gray on Healy Creek.

In October 1994, state trappers observed a pair of wolf tracks in the Healy Creek area on 2 different occasions. Then, the alpha male wearing a failed radio collar deployed by the NPS in 1990, was shot by a state trapper in upper Moody Creek on 31 October. At that time, the male was alone. The fate of the male's mate, who was also wearing a failed radio collar, was unknown, but we did not see evidence of her during the remainder of the winter.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	6 gray	2 gray
Spring pack size and color composition	2 gray	0 gray
Wolves killed by state trappers	3 gray	1 gray
Wolves killed by private trappers and hunters	1 gray	0 gray
Total harvest	4 gray	1 gray

BLAIR LAKES PACK

On 7 November 1993 state trappers saw a track of 6–7 wolves south of Blair Lakes hills and a track of 12–14 approximately 5 miles to the north of Blair Lakes hills. Those 2 tracks indicated the Blair and Clear Creek packs existed as separate packs sharing a common territory boundary near Blair Lakes. On 23 November, state trappers saw 1 black and 2 gray wolves associated with a track of an estimated 6 wolves and on the same day, the Clear Creek pack of 6 blacks and 5 grays was seen near Clear Creek Butte. The concurrent sighting of both packs provided clear evidence of their separate identities. In late January state trappers saw the track of an estimated 10 wolves 5 miles south of Blair Lakes, then on 15 February they saw 3 blacks and 5 grays south of Blair Lakes on Dry Creek.

The range of the Blair Lakes pack in winter 1993–1994 probably included the Blair Lakes hills and lands to the east as far as the Tanana River. The Clear Creek pack ventured to within a few miles of Blair Lakes to the north, and the Spirk pack occupied the Dry Creek Flats south of Blair Lakes. Military Restricted area R-2211, lies immediately east of Blair Lakes and it is likely the Blair pack ranged within that area also, but overflight of the restricted area was generally prohibited by the military and we were unable to conduct wolf track surveys within the restricted area following a fresh snowfall.

Prior to the 15 February sighting, a private trapper had taken 1 black and 1 gray near Elbow Lake in late January. Therefore autumn 1993 pack size was a minimum of 10 wolves; 4 black and 6 gray. A second trapper took 1 black and 1 gray on 13 March, 1994 south of Blair Lakes, and state trappers killed 1 black pup south of Blair Lakes on 30 March. Subtracting known harvest from the 15 February sighting resulted in a spring pack size estimate of 5 wolves, 1 black and 4 gray.

In autumn 1994, state trappers followed tracks of the Blair Lakes pack on 2 different days in late October, but did not see the pack. Reports from the private trapper who trapped in that area indicated the pack consisted of 7 wolves. He trapped 2, a black and a gray.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	10 (4b,6g)	7 unk color
Spring pack size and color composition	5 (1b,4g)	5
Wolves killed by state trappers	1 black	0
Wolves killed by private trappers and hunters	4 (2b,2g)	2 (1b,1g)
Total harvest	5 (3b,2g)	2 (1b,1g)

WOOD RIVER PACK

The Wood River pack occupied a territory along the lower Wood River near the Wood River Buttes during winter 1993–1994. The pack roamed west to the Tatlanika River and south to within a few miles of the Alaska Range foothills. State trappers saw the pack on 3 occasions; 15 grays were seen on both 17 November and 1 December, and 9 grays were seen on 9 December.

State trappers took 9 wolves from this pack's range between 1 December and 31 January. A private trapper took 2. None of the wolves taken by state trappers were older than 2 years of age, and both of those taken by a private trapper were yearlings. Therefore, the alpha pair probably survived until spring. The age structure as determined from harvested animals, suggested that pair had produced pups since at least May 1991.

The pack was not sighted during the autumn 1994, but in late October a track of 6 wolves was followed along the lower Wood River and the track of a pair was sighted in the vicinity of the Wood River Buttes. A private trapper took 6 grays from the territory of the Wood River pack in January 1995 and we believe, eliminated the pack.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	15 gray	6 gray
Spring pack size and color composition	4 gray	0
Wolves killed by state trappers	9 gray	0
Wolves killed by private trappers and hunters	2 gray	6 gray
Total harvest	11 gray	6 gray

CLEAR-SALCHAKET PACK

A large group of wolves occupied the Clear Creek/Salchaket Slough area in autumn 1993. The pack ranged south to Blair Lakes, east to the Tanana River, and west to Willow Creek. Several sightings of a large number of wolves (about 12–20) in the Clear Creek area and of a smaller groups (about 5–7) in the Salchaket area indicated there may be 2 separate packs. However the apparent range of the larger pack appeared to encompass the unrealistically small range of the smaller group. The smaller group was consistently seen in an area of concentrated wintering moose, while the larger group was seen throughout its larger range. For the purposes of the population estimate, those 2 groups were combined into a single pack.

The entire range of this large group of wolves lay within the boundaries of a military reservation. The prescription for the wolf control program specifically excluded military lands from wolf control operations by the state, but the military lands were open to trapping by private trappers.

The autumn 1993 pack size was based on the sighting of 3 black and 2 gray wolves in the Salchaket group on 7 November, and the observation of a track of 12–14 wolves north of Blair Lakes on the same day. On 23 November 1 black and 2 grays were seen in the Salchaket group and 6 black and 5 grays in the Clear Creek group, by 2 separate aircraft at approximately the same time. On 21 November, 6 blacks and 6 grays had been seen in the

Clear Creek group near the mouth of Salchaket Slough. Assuming the 2 groups were separate at the time of those sightings, the autumn group size was 17, 9 blacks and 8 grays.

Military helicopter pilots reported seeing a pack of approximately 20 wolves (mixed blacks and grays) in the Willow Creek area prior to our sightings. This suggests the pack had split into 2 smaller groups, 1 occupying the northern portion of its range and the second Clear Creek group moving over the entire range. However, at times the group may have traveled as a single pack, as suggested by a sighting of 14 wolves by a local pilot on the Tanana River near the town of North Pole in late January. This was after 2 wolves had been harvested from the Salchaket group.

In March observations of a track of 2 wolves was seen twice in the Salchaket area, and a group of 5 was tracked on 3 different days within the range of the Clear Creek group. On 21 March, 3 blacks and 2 grays were tracked east of Clear Creek Butte on the same day a fresh track of the pair was found on the Tanana River near Salchaket Island. The discrepancy between autumn pack size minus harvest and spring pack size could easily have been the result of dispersal and spring breeding activity during March. It is probable that a pack of 17 wolves would contain several subordinate wolves of breeding age.

In autumn 1994 the Clear Creek pack contained 7 wolves, 5 blacks and 2 grays in a single pack whose range apparently centered along Clear Creek from the Tanana River south to military restricted area R-2211. We did not see evidence of a separate small group of wolves along Salchaket Slough as seen in 1993. No harvest by either state or private trappers was reported from this pack in winter 1994–1995.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	17 (9b,8g)	7 (5b,2g)
Spring pack size and color composition	7 (4b,3g)	7 (5b,2g)
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	5 (2b,3g)	0
Total harvest	5 (2b,3g)	0

CROOKED CREEK PACK

The Crooked Creek pack ranged along the Tanana River between Willow Creek and the Wood River south to near Wood River Buttes. This pack was similar in size and color composition to the adjacent Clear Creek pack. The pack of 8 wolves (4 black and 4 gray) were first sighted on 20 November 1993 near Willow Creek. The following day the Clear Creek pack (6 black and 6 gray) was sighted at the mouth of Salchaket Slough approximately 10 miles to the north. Tracks from those packs indicated they were separate groups of wolves. On both 9 December and 12 December fresh tracks of 6–8 wolves were observed near Crooked Creek, 36 miles east of a 10 December sighting of the Clear Creek pack of 5 grays and 5 blacks on the Tanana River near Eielson Air Force Base. Those sightings again supported the existence of a separate Crooked Creek pack, although the pack size and color composition were similar between the Crooked Creek and Clear Creek packs. On

28 December, 24 January, and 7 February tracks of 6–8 wolves were sighted in the Crooked Creek drainage.

During winter 1993–1994, private trappers took 5 Crooked Creek wolves between December and February. In addition, a 2-year-old male wolf was found dead by a trapper near the mouth of Crooked Creek in early January, apparently killed by other wolves. It was unknown whether that wolf was from the Crooked Creek pack or was trespassing into the Crooked Creek territory. Tracks of the Crooked Creek pack crossed the Tanana River to the north and their territory probably ranged into Unit 20B.

Fresh tracks of the Crooked Creek pack were observed on 3 days during March in the area between Willow Creek and Crooked Creek. In each case, observers estimated only 3–4 wolves in the pack. This pack size was consistent with the February harvest by private trappers. None of the wolves taken by private trappers were breeding adults, suggesting the alpha pair survived.

In autumn 1994, the Crooked Creek pack numbered at least 11 wolves. Tracks of the pack were seen near Willow Creek, and on the Tanana River in late October, and the pack of 6 grays and 5 blacks was seen on 13 November. During winter 1994–1995, only one wolf was reported killed from the Crooked Creek pack.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	8 (4b,4g)	11 (5b,6g)
Spring pack size and color composition	3 (2b, 1g)	10 (5b,5g)
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	5 (2b,3g)	1 gray
Total harvest	5 (2b,3g)	1 gray

WHISKEY PACK

A small group of wolves was repeatedly sighted by both state and private trappers near Whiskey Island on the Tanana River in Unit 20A. It is likely the Whiskey pack ranged north across the river into Unit 20B. State trappers first saw 1 black and 2 grays near the mouth of the Wood River on 17 November 1993. Private trappers then snared 2 wolves west of Whiskey Island on 7 January 1994. One of the trappers saw 2 additional wolves (a black and a gray) near his trap site. Tracks of 2–3 wolves were also observed near the mouth of the Wood River on 1 February and 26 February.

The sightings of this pack were confined to an area along the Tanana River between Whiskey Island and Wood River, a distance of about 8 miles. Territories of the Wood River pack, the Crooked Creek pack, and the Lower Tatlanika pack also converged in this area. Therefore it seems unlikely that the Whiskey group ranged very far south into Unit 20A, but probably occupied an area to the north of the Tanana River in Unit 20B. A wintering concentration of moose existed along the Tanana between Whiskey Island and the mouth of the Wood River and could have resulted in frequent visits by the Whiskey pack to the area between Whiskey Island and the mouth of the Wood River.

In autumn 1994 a track of 6 wolves was seen near the mouth of the Wood River.

That track traversed what would have been the range of the 1993 Whiskey pack, however it is believed those tracks were associated with the Wood River Pack of 6 gray wolves that were killed by a private trapper near the Wood River in January 1995. The fate of the remaining members of the Whiskey pack is unknown but we did not find clear evidence of their existence within Unit 20A during winter 1994–1995.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	4 (1b,2g,1unk)	0
Spring pack size and color composition	2 (1b,1unk)	0
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	2g	0
Total harvest	2g	0

7-MILE PACK

In autumn 1993 the 7-mile pack territory abutted that of the Jumbo pack, but the 7-mile pack contained primarily gray wolves, the Jumbo pack was primarily black wolves. The 7-mile pack's range included the area surrounding Rex Dome and extended north into the Tanana Flats along the Totatlanika River near 7-mile lake. The best observation of this pack occurred on 28 October, 1993 when state trappers saw 11 wolves, 3 black and 8 gray stalking a moose north of Rex Dome. The wolves subsequently killed a moose in this area and state trappers used the kill as a trap site.

State trappers killed 7 wolves (1 black, 6 gray) from this pack between 23 October and 15 November, 1993 including the alpha pair. A private trapper caught 2 grays and 1 black, also in early November. Then a private hunter shot a 3-year-old gray male from a group of 1 gray and 2 blacks on 8 January near the Rex Trail, but that wolf may have been an immigrant. Certainly after the demise of the alpha pair, remaining pack members could more easily associate with single wolves moving into the territory. However, the 3-year-old male is included as part of the 7-mile harvest because it was taken near the center of the 7-mile territory when at least some of the 7-mile wolves still occupied the territory. State trappers took a black pup in February. The reproductive tract of the alpha female indicated she had produced 8 pups in May 1993.

Our initial estimate of 13, 9 gray and 4 black, was calculated using the chronology of harvest in association with the sightings of 28 October and 8 January. At least one wolf probably survived from this pack.

In autumn 1994 a track of about 5 wolves was followed through the territory of the 7-mile pack for several miles but the wolves were not sighted. In March 1995 a private trapper took 2 males, a black and a gray, from a pack of 4 within the 7-mile territory. It is unknown if those wolves included the survivor of the 7-mile pack .

	Regulatory year

	1993	1994
Autumn pack size and color composition	13 (9g,4b)	5
Spring pack size and color composition	1 black	2
Wolves killed by state trappers	8 (2b,6g)	0
Wolves killed by private trappers and hunters	4 (1b,3g)	2 (1b,1g)
Total harvest	12 (3b,9g)	2 (1b,1g)

TOTATLANIKA PACK

This pack's range included the western Tanana Flats from the Tanana River to within about 5 miles of the foothills. Its range appeared to abut that of the 7-mile Dome and Steep Creek packs to the south and southeast. Initial evidence of the pack was based on the 21 October 1993 sighting of tracks of 5 wolves on the Totatlanika River 4 miles upstream from the mouth. State trappers saw a track of 6–9 wolves in December, a track of 4–5 wolves in early February and a track of 5–6 wolves in mid-February, all in the same area. The only sighting of the pack occurred on 6 March when state trappers saw 2 blacks and 2 grays near an old kill on the Totatlanika about 8 miles north of the foothills. Using that sighting and the prior harvest, we estimated an autumn pack size of 6 wolves containing both blacks and grays.

A trapper reported taking a female wolf of unspecified color in the upper portion of the Fish Creek drainage in January; he estimated 4 in the pack from tracks at his set. The same trapper later took a gray female near Nenana on the Tanana River from a pack of 2. That wolf was taken in early March 1994 and may have been from the Totatlanika pack or may have been from an unidentified pair. For the purpose of the estimate, the March wolf was considered a Totatlanika wolf.

In October 1994 state trappers saw 9 wolves (5bl and 4g) in the Totatlanika pack near the confluence of the Totatlanika and Tanana Rivers. The pack ranged from the mouth of the Totatlanika River at least 15 miles to the south. State trappers did not take wolves from this pack in either the 1993 or 1994 winter, and no private trappers reported harvest from the territory of this pack in winter 1994–1995.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	6 (2b,3g,1unk)	9 (5b,4g)
Spring pack size and color composition	4 (2b,2g)	9 (5b,4g)
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	2 (1g,1unk)	0
Total harvest	2 (1g,1unk)	0

COAL CREEK PACK

Tracks of the Coal Creek pack were first seen near Saint George Creek in mid-October 1993. Subsequent track sightings and captured wolves indicated the pack ranged east to the Wood River in the vicinity of Mystic Creek and Coal Creek. We believe the pack numbered approximately 7 wolves (4 blacks and 3 grays) in October. All were killed by late March 1994. The alpha female was killed by state trappers on Coal Creek in late October, a female pup was taken near the Wood River by a private trapper in December, 2 pups and 2 yearlings

were taken in mid February at the site where the alpha female had been snared, and the alpha male was killed by a private trapper on Bonnifield Creek in mid-March. The reproductive tract from the alpha female suggested she had produced 5 pups the previous spring.

Three other wolves were taken within the home range of this pack during spring 1994. Two males (a yearling and a 3-year old) appeared to be single animals when caught and were thought to be dispersers, not associated with the original Coal Creek pack. A 2-year-old female was trapped with the alpha male in mid-March. The trapper who killed the alpha male reported that tracks of only 2 wolves were present at the trap site, which was at the northern edge of the Coal Creek pack's range. It seems likely the male paired with the 2-year female after the remainder of his pack had been killed in mid February and we assumed the 2-year-old female was not a part of the original pack. All members of Coal Creek pack were probably killed by late March 1994.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	7 (4b,3g)	0
Spring pack size and color composition	0	0
Wolves killed by state trappers	5 (4b,1g)	0
Wolves killed by private trappers and hunters	2 gray	0
Total harvest	7 (4b,3g)	0

NEWMAN CREEK PACK

The Newman Creek pack contained 6 gray wolves in early November 1993. They occupied a range that included the drainage of the West Fork of the Little Delta River, and the mountainous portion of the Dry Creek drainage. Their territory appeared to be centered around Newman Creek. State trappers first saw a track of 6 in early November that ran from the West Fork over the divide into Newman Creek and in late November they followed a very fresh track of 6 to near the headwaters of Dry Creek where the track was lost in fog. The only 2 sightings of the pack occurred on 21 December when 1 gray was seen associated with a track of an estimated 6 wolves west of the Little Delta River, and on 15 February when 4 wolves were tracked from the upper West Fork to a fresh kill north of Iowa Ridge. A track of 4 wolves was seen on 7 February that led from upper Snow Mountain Gulch into Slide Creek, an area where we had found 3 kills attributed to the Newman Creek pack. Moose and caribou kills made by this pack were located on the north slope of Iowa Ridge, near Newman Creek, and in the Slide Creek drainage west of Dry Creek.

Private trappers did not report any harvest from within the range of this pack, but state trappers killed 2 female wolves in mid December 1993, a 3-year old that had been pregnant with 5 fetuses and a yearling. The last evidence of the Newman Creek pack was seen during the breeding season on 9 March when state trappers saw a pair of tracks at a moose kill. The kill had been made by the Newman Creek pack on 15 February. Therefore, the alpha female may have been killed (i.e., 3 yr female taken by state trappers), but the alpha male probably survived.

On 14 November 1994, the Newman Creek pack of 5 grays was seen traversing the north side of Iowa Ridge. In December, state trappers killed 3 wolves including an adult male, a yearling male and a pup in upper Dry Creek. Those wolves were probably from the Newman pack and indicate that the pack did produce pups in spring 1994. The 3 yr. male may have been the alpha male from this pack, so in contrast to winter 1993–1994, it is likely that during winter 1994–1995, the alpha male was killed and the alpha female survived. If so, by spring 1995, the pack did not contain either of the alpha pair that existed in the original Newman pack at the beginning of wolf control in autumn 1993.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	6 gray	5 gray
Spring pack size and color composition	4 gray	2 gray
Wolves killed by state trappers	2 gray	3 gray
Wolves killed by private trappers and hunters	0 gray	0
Total harvest	2 gray	3 gray

STEEP PACK

The Steep Creek pack occupied a territory along the northern foothills of the Alaska Range centered on the upper Totatlanika River. The Steep Creek pack was first sighted on 4 November when state trappers saw 4 grays and 1 black near a fresh moose kill. Prior to that sighting private hunters and trappers had killed 1 black and 2 gray wolves within the pack's range. Subsequent sightings and harvest from within the pack's range indicated the initial autumn population size was 11 wolves, 4 blacks and 7 grays.

State trappers took 4 wolves from the Steep Creek pack between December and March, and private hunters and trappers took 3 wolves between September and early November.

Although the color composition and number of wolves in this pack is similar to both the 7-Mile pack and the Totatlanika pack, the 7-mile pack was virtually eliminated early in the winter, while the Steep Creek pack persisted as a group of at least 6 until March. The Totatlanika pack of 2 gray and 2 black was seen on the Totatlanika near the range of the Steep Creek pack on 6 March, a distance of approximately 30 miles direct line from a 7 March sighting of the Steep Creek pack near the Jackson airstrip. In addition, the wolves seen on the Totatlanika were near a track segment that had previously tied into the Totatlanika pack at the mouth of the Totatlanika on the Tanana River. These observations supported the conclusion of separate packs.

None of the female wolves taken by state trappers had produced pups the previous year, and at least 2 of the 3 wolves taken by private trappers and hunters were pups. Therefore, at least 1 and probably both of the alpha pair survived.

With the demise of the Tatlanika Pack, the Steep Creek pack shifted its range eastward and occupied both the upper Totatlanika and Tatlanika drainages during winter 1994–1995. The Steep Creek pack was first seen that winter near Boulder Creek on 6 November 1994. The pack contained 8 wolves, 5 grays and 3 blacks after one black pup had been snared. State

trappers killed 3 pups from this pack during winter 1994–1995, no harvest was reported by private trappers. Biologists collared this pack in March 1995 and at that time the pack contained 6 wolves, 4 gray and 2 blacks. All of the wolves killed during winter 1994–1995 were pups, and the alpha pair apparently survived at least until spring 1995. The 2 wolves collared in March were both male pups; therefore the autumn 1994 pack contained at least 6 pups, 4 males and 2 females.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	11 (4b,7g)	9 (4b,5g)
Spring pack size and color composition	4 (3b,1g)	6 (2b,4g)
Wolves killed by state trappers	4 gray	3 (2b,1g)
Wolves killed by private trappers and hunters	3 (1b,2g)	0
Total harvest	7 (1b, 6g)	3 (2b,1g)

GOLD KING PACK

This pack was first detected in September 1994 when moose hunters reported seeing a pack of 7 wolves in the Japan Hills. State biologists subsequently tracked and sighted the wolves on 3 occasions in October and November. The pack, containing 3 blacks and 4 grays, was sighted on 11 November in the Japan Hills and the Mystic Pack whose territory lay just to the south of the Japan Hills was located in the mountains between Mystic and Saint George Creek on both November 8 and November 14. Those sightings placed the Mystic pack about 10 miles south of the 11 November sighting of the Gold King pack and support the presumption of separate packs. Two wolves were killed by a private trapper within the presumed range of the Gold King pack but the age of those wolves was undetermined.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	0	7 (3b,4g)
Spring pack size and color composition	0	5 (2b,3g)
Wolves killed by state trappers	0	0
Wolves killed by private trappers and hunters	0	2 (1b,1g)
Total harvest	0	2 (1b,1g)

BAKER PACK

This pack was first identified during a wolf survey in spring 1992. At that time the Baker Pack consisted of 12 grays and was easily distinguished from the adjacent Tata Pack of 10 grays because 2 Tata wolves, including the alpha female were radiocollared. The Baker pack ranged between the Tatlanika River and the Wood River near VABM Baker, on a series of plateaus known locally as the Gold King Benches. In October 1993 the pack contained 9 grays. Department hunters shot 2 gray males near upper Saint George Creek in late October; one of those was probably the alpha male (7 years old), the other was a pup. Earlier, in September 1993, a hunter killed a gray male from within the range of this pack but its age was unknown.

In August 1994 hunters killed 2 gray female pups from a pack of 9 thought to be the Baker pack. In late October tracks of an estimated 7–10 wolves were seen near a kill in the center of the Baker territory. No other wolves were known to have been taken from this pack but color composition of the pack was unknown in 1994, a trapper took 2 blacks and 1 gray along the Wood River adjacent to the territory of the Baker Pack during midwinter, those may have been part of the Baker pack.

	Regulatory year	
	1993	1994
Autumn pack size and color composition	10 gray	9
Spring pack size and color composition	7 gray	7
Wolves killed by state trappers	2 gray	0
Wolves killed by private trappers and hunters	1	2 gray
Total harvest	3 gray	2 gray

APPENDIX A Continued

Table 1 Estimated pack size and harvest of 24 wolf packs in Unit 20A, October 1993–April 1994

Pack name	Estimated pack size		Harvest		
	Autumn	Spring	Department	Private	Trapping total
Cody	8	2	5	1	6
Yanert	27	11	6	10	16
Rainbow	17	8	0	9	9
West Fork	7	4	3	0	3
Mystic	3	3	0	0	0
Jumbo	13	3	9	1	10
100-Mile	9	5	1	3	4
Tata	12	3	9	0	9
Snow Mountain	3	1	2	0	2
Spirk	12	2	9	1	10
Ptarmigan	3	3	0	0	0
Iowa Ridge	18	1	17	0	17
Healy	6	2	3	1	4
Blair Lakes	10	5	1	4	5
Wood River	15	4	9	2	11
Clear Creek/Salchaket	17	7	0	5	5
Crooked Creek	8	3	0	5	5
WHISKEY ISLAND	4	2	0	2	2
7-Mile	13	1	8	4	12
Totatlanika	6	4	0	2	2
Coal Creek	7	0	5	2	7
Newman Creek	6	4	2	0	2
Steep Creek	11	4	4	3	7
Baker	10	7	2	1	3
Unknown Pack Assoc.	10	0	4	6	10
Totals	255	89	99	62	161

Table 2 Estimated pack size and harvest of 22 wolf packs in Unit 20A, October 1994–April 1995

Pack name	Estimated pack size		Harvest		
	Autumn	Spring	Department	Private	Trapping total
Cody	5	1	3	0	3
Yanert	25	11	12	2	14
Rainbow	11	5	0	5	5
West Fork	8	2	6	0	6
Mystic	11	8	3	0	3
Jumbo	6	4	2	0	2
100-Mile	14	11	3	0	3
Tata	3	0	0	0	0
Spirk	7	7	0	0	0
Ptarmigan	2	2	0	0	0
Healy	2	0	1	0	1
Blair Lakes	7	5	0	2	2
Wood River	6	0	0	0	0
Clear Creek/Salchaket	7	7	0	0	0
Crooked Creek	11	10	0	1	1
7-Mile	5	2	0	2	2
Totatlanika	9	9	0	0	0
Newman Creek	5	2	3	0	3
Steep Creek	9	6	3	0	3
Gold King	7	5	0	2	2
Baker	9	7	0	2	2
Unknown Pack Assoc.	6	0	0	6	6
Totals	175	104	36	28	64

APPENDIX B Wildlife Research Study Plan

Grant
Study

Study Duration
From: 1 July 2000
To: 30 June 2003

WILDLIFE RESEARCH STUDY PLAN

Alaska Department of Fish and Game
Division of Wildlife Conservation

STUDY TITLE: Predation by a regulated wolf population on moose and caribou

THE PROBLEM OR NEED:

1 Statement

Recently, the wolf management controversy in Alaska has focused on 2 issues. First, whether reducing wolf populations will, or will not, result in increased moose and caribou populations, and secondly, what socially-acceptable methods can be used to reduce wolf predation on moose and caribou.

The debate over the efficacy of wolf control persists because some past wolf control programs have failed to produce measurable increases in moose or caribou, while other programs clearly have (Gasaway et al. 1983). Public attitudes toward wolf control methods reflect changes in the value systems of Alaskan society. Control methods used before statehood are now either considered to be unacceptable (i.e., poisoning and denning) or increasingly unpopular (e.g., aerial gunning). “Far greater support exists for ground-based hunting, trapping and snaring to kill wolves. Most Alaskans support wolf and bear control by local hunters rather than by professional wildlife personnel” (National Academy 1997). Consistent with those National Academy of Sciences findings, recent proposals to the Board of Game for wolf predation control have advocated increased harvest by local users, and private organizations have developed monetary incentive programs to encourage local hunters and trappers to kill more wolves. We believe future management of wolf predation on moose and caribou will continue to focus on ground-based hunting and trapping by local hunters and trappers.

Predation rates by wolves on moose and caribou are related to both the number of wolves and to the number of wolf packs within a population. Wolf populations that are harvested by hunting and trapping at moderate levels may be efficiently regulated numerically, but not socially. Conceivably, light to moderately exploited wolf populations could instantaneously increase per capita predation and annually increase finite growth rates so that total predation rates are similar to those of an unregulated wolf population. Therefore, before manipulating wolf populations to reduce predation, managers must be able to estimate predation rates from regulated vs. unregulated wolf populations.

To estimate winter predation rates by wolves in northern ecosystems, biologists customarily follow wolf packs from the air for a specified number of consecutive days and record the number of kills. It is important that flights be conducted frequently because wolves may totally consume caribou or sheep kills within a few hours. Previous studies contained 1 or 2 sampling periods each of 20–45 days, in either early or late winter. (Ballard et al. 1987; Hayes et al. 1991; Dale et al. 1995). However, prey vulnerability to wolf predation changes throughout winter. Some sex and age classes are inherently more vulnerable in early vs. late winter, and seasonal snow depths and prey distribution change overall prey vulnerability (Mech et al. 1995). Continuous, daily monitoring of wolf packs throughout the winter is impractical, but surveys flown in only 1 or 2 periods of the winter (e.g., early winter and late winter) are inherently biased. Theoretically, an unbiased estimate of wolf predation, with an estimate of precision, could be obtained by flying frequent, short (3–10 day) sampling periods throughout the winter. That method would also be cost-effective and practical.

This proposed study seeks to 1) develop and conduct an unbiased aerial survey method to estimate predation rates on moose and caribou by a wolf population that is regulated by ground-based hunting and trapping, 2) identify predation rate characteristics associated with packs of different size and social structure, 3) integrate those findings with results of a previous study on wolf population responses to trapping and hunting (Federal Aid in Wildlife Restoration Study 14.17), and 4) develop recommendations for the use of ground-based hunting and trapping to manage wolf predation on moose and caribou. The findings of the study will be evaluated relative to current wolf-ungulate management practices and relative to public concerns regarding the harvest and status of Alaskan wolves.

2 Justification

Both aerial hunting and ground-based hunting and trapping of wolves can limit, or regulate, wolf numbers below natural levels (McNay 1999), but the social structure and consequently predation characteristics of wolf populations may be different for wolf populations regulated by ground-based vs. aerial control. Future attempts to regulate wolf populations for the purpose of reducing predation on moose and caribou will focus on ground-based hunting and trapping by local hunters. In that management context, case histories documenting the efficacy of aerial wolf control will not be relevant. Instead managers will need a better understanding of predation

characteristics of wolf populations that are regulated by ground-based hunting and trapping.

The proposed study is needed to integrate new, unbiased data on predation rates with existing information on the population characteristics of wolf populations regulated by hunting and trapping. That analysis will allow us to refine predictive models (McNay and DeLong 1998) and will lead to more realistic predictions on the efficiency of ground-based hunting and trapping in reducing wolf predation.

3 Background

History of Study Area

The wolf population in Unit 20A has been subjected to 3 government wolf control programs since 1954 and continuous annual harvests by public hunters and trappers each year. In each case, government wolf control was applied to reduce wolf predation on moose and caribou, thereby increasing the allowable harvest of ungulates by hunters. Gasaway et al. (1983) and Boertje et al. (1996) gave a detailed history of the first 2 control programs; a brief summary follows.

High wolf numbers in the early 1950s were reduced by poisoning and aerial shooting to a density of approximately 4 wolves/1000 km^2 between 1954 and 1960. Moose numbers increased to high densities (≥ 1300 moose/1000 km^2) by the mid-1960s, then crashed to a low density (165 moose/1000 km^2) by 1975. After wolf control ended in 1960, wolves increased and attained densities of 16 wolves/1000 km^2 by 1970. Beginning in 1976, wolves were again reduced by aerial shooting to a late winter 1979 density of 3 wolves/1000 km^2. Moose and caribou increased in response to the wolf control program, and after cessation of wolf control in 1982, wolves increased to a density of 16 wolves/1000 km^2 by autumn 1991.

Wolves were reduced during a third government wolf control program during winter 1993–1994 to an estimated density of 6.5 wolves/1000 km^2. An additional 66 wolves removed during winter 1994–1995 did not further reduce, but held the wolf population stable at a late winter density of 6–7 wolves per 1000 km^2. This third control program was conducted almost entirely using snares and traps deployed by both government and private trappers, and serves as an example of an intensive, ground-based control effort. After control ended in December 1994, local hunters and trappers continued to hunt and trap wolves, but at a reduced rate compared to harvests during the control program.

Beginning in March 1995, the Department of Fish and Game initiated a study to monitor the population dynamics of the recovering wolf population in Unit 20A. Between 1995 and March 1999, we captured 173 wolves 254 times and fitted radio collars to 133 wolves among 32 packs. We obtained approximately 5500 wolf locations and 2000 pack locations by locating radiotransmitters from the air. We purchased 248 wolf carcasses from trappers within the study area between 1993 and 1999 and we conducted postmortem examinations on those carcasses. We determined sex and age for all carcasses, and reproductive history among adult females. Where

possible, we assigned a pack affiliation to carcasses based on when and where the wolf was killed and upon corresponding changes in counts of monitored packs. We also conducted postmortem examinations on an additional 135 wolves that were killed by state trappers during the 1993–1995 wolf control program.

Preliminary results indicate, that in some years, ground-based hunting and trapping regulated wolf densities well below natural densities, and that lower wolf densities were achieved by reduced mean pack size, rather than by reduced numbers of packs. In addition, harvest by local hunters and trappers focused on particular packs, leaving some packs unexploited and others substantially reduced. Therefore, more diversity in wolf pack size may occur in heavily trapped wolf populations vs. naturally-regulated populations, even though pack density in the 2 types of populations may be similar.

Among wolf populations that have been regulated using aerial wolf control, entire packs are often removed and pack densities as well as wolf densities are reduced temporarily. However, recolonization can be rapid. Hayes et al. (1991) reported little change in pack density during an intensive aerial wolf control program, but after 3 years of aerial control, 13 of the 18 packs identified in the first year of recovery were new colonizing packs. In contrast, after 2 years of ground-based control in the foothills of Unit 20A, 14 of 15 packs present in the first year of recovery were also present precontrol, because intensive ground–based trapping removed a high proportion of young wolves, (i.e., pups and yearlings), but a low proportion of dominant adults.

During our 1995–1999 study of wolves in Unit 20A, we intensively monitored study packs, captured most of the animals in some packs, and purchased carcasses from trappers who caught animals from study packs. As a result we gained substantial knowledge on the sex, age, and social composition of several wolf packs, including interrelationships between members of different packs. We feel that social composition data may be significant in predicting predation rates by wolf packs that are regulated by ground-based hunting and trapping.

Predation Rates

Early attempts to estimate predation rates used the average number of kills observed per day to extrapolate a kill rate for an entire winter (Mech 1977). However, flights were not necessarily conducted on consecutive days and widely disparate handling times by wolves on different prey types (moose vs. deer) probably resulted in an underestimate of deer predation relative to moose predation. Fuller and Keith (1980) improved on predation rate estimates by flying a single pack of 10 wolves continuously for 55 and 66 consecutive days in late winter 1977 and 1978, respectively. From those observations they calculated a regression relating actual kill rates to the number of kills that would have been sighted had they flown at intervals of from 2–6 days. They applied that regression to kills made by other packs for which they had nonconsecutive day locations. Peterson et al. (1984) used the same regression for estimating kill rates on the Kenai Peninsula, Alaska. However, in both studies the

regression was not adjusted for different handling times by different pack sizes, so for small packs the method probably overestimated the kill rate of moose.

Hayes et al. (1991) and Hayes et al. (2000) conducted predation rate studies that were based on long, consecutive-day survey periods in an attempt to observe all ungulate kills made by wolves. Those and other studies have examined the relationship between pack size and kill rate. Typically, large packs kill more prey than small packs, but per capita consumption of prey by wolves is greater among small packs (Ballard et al. 1987; Ballard et al. 1997; Hayes et al. 2000). That characteristic is key to wolf predation management because it implies that a reduction in wolf numbers will not result in a proportional reduction in predation rates if the number of packs remains the same. For example, using their kill rate data, Hayes et al. (2000) modeled 3 predator-prey systems each containing 100 wolves, but mean pack size varied from 3.8 to 6.25 wolves per pack. The predicted winter kill of moose by the simulated wolf population with the lowest mean pack size ($\bar{x}$ = 3.8) was 38% higher than for the population with a high mean pack size ($\bar{x}$ = 6.25).

In Alaska and Yukon, detailed estimates of predation rates have been published for a naturally-regulated wolf populations (Dale et al. 1995), populations controlled by aerial gunning (Ballard et al. 1987; Hayes et al. 1991, Hayes et al. 2000), and for a population regulated by a combination of disease (rabies), aircraft hunting, and snowmachine pursuit (Ballard et al. 1997). Predation rates have not been reported for wolf populations regulated by ground-based trapping and hunting. All of the published predation rate estimates for Alaska and Yukon were based on seasonal surveys and therefore do not represent total winter predation rates because prey vulnerability changes with season. Among harvested wolf populations, changes in pack size and structure throughout winter may add another source of bias to predation rate estimates based on early or late winter sampling.

Pilot Study Results

In 1998 we designed a survey method to estimate predation rates that was not biased by seasonal sampling. We began by building a computer simulation to see if, through periodic sampling, we could achieve adequate precision and avoid seasonal bias, without having to fly more than 45 days during the winter.

We constructed a table of expected intervals between wolf kills using empirical wolf consumption rates (Ballard et al. 1997) and prey sex-age composition data (Mech et al. 1995). To provide random variation, we assumed a Poisson distribution (i.e., variance = mean) for the empirical wolf consumption rates. The table included expected intervals (in days) following a caribou kill and following a moose kill for wolf pack sizes of 2–15. The mean interval following moose kills was longer (2.49×) than that following caribou kills because moose provided more food biomass per kill. We then constructed 2 transition matrices that described the probabilities that wolves would kill either a moose or a caribou in our simulated ecosystem following the kill of either a moose or a caribou. In the first case, we assumed that wolves preyed primarily on moose because moose were evenly distributed and more abundant in the study area

than caribou (moose prey matrix). For the second case, we assumed that once a pack killed a caribou, the probability increased that the pack would kill another caribou. That transition matrix simulated the clumped distribution of caribou and reflected a preferred preference by wolves for caribou when available (caribou/moose matrix).

Then for each pack size of 2, 5, 7, 10, and 14 we constructed a "true" kill sequence for each transition matrix. Once the true kill sequences were established we applied 5 periodic sampling designs to kill sequences for each of the 5 pack sizes among each of the 2 transition matrices. All sample designs consisted of 42 to 45 total flying days, but they were divided into randomly distributed sequences of 2-, 3-, 4-, 5-, or 6-day periods. For example, one sample design called for twenty-two 2-day flying periods randomly distributed throughout the winter, another called for seven 6-day periods. Estimated kill for each simulation was calculated as $(K/N) * D$, where K= # of kills detected, N = number of sample days, and D = number of days in winter. N, the number of sample days, was defined as $F–P$, where F = total flying days (i.e., 42–45) and P = number of random periods, because the first day of each period was not included as a sample day. K was calculated for caribou, moose, and total ungulates for each of the simulations. We simulated 100 winters of sampling for each of the 50 combinations of pack size, sample design, and transition matrix.

Results of the simulations were evaluated in terms of the mean square error value resulting from the 100 simulations for each sample design/pack/matrix combination. Based on those values, we chose a sample design that called for eleven 4-day sampling periods. Predicted 90% confidence limits around the true kill for all pack sizes pooled, were ± 24% for the moose prey matrix and ± 22% for the caribou/moose prey matrix. Increased length of sampling periods marginally increased precision, but we believed weather constraints would prevent us from completing 6-day sampling periods.

We applied our simulation as a field test during winter 1998. We successfully monitored 12 wolf packs varying in size from 1 to 15 wolves during ten 4-day periods and detected 24 kills made by 6 of the monitored packs during sampling periods. Results from the survey have been entered into a database and we plan to finish the analysis in summer 2000. The pilot study demonstrated that kills could be detected during short sample periods, and that the technique could be applied as designed without significant interruption by weather. We anticipate some modifications in sample design. Those modifications will be developed after we evaluate the final result of the pilot study and pending approval of this new study proposal.

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STUDY OBJECTIVE

The study objective is to describe the potential for ground-based hunting and trapping to regulate wolf populations and reduce wolf predation on moose and caribou. To achieve the objective we proposed to analyze population characteristics of a regulated wolf population relative to predation rates on moose and caribou exhibited by that population. We believe the resultant models will more effectively meet the needs of managers who are asked to regulate wolf numbers and wolf predation through local hunting and trapping efforts. We believe that case histories describing wolf regulation by aerial control are largely irrelevant in predicting the consequences of ground-based hunting and trapping.

EXPECTED RESULTS AND BENEFITS

- A new technique for estimating wolf predation rates on moose and caribou that is not biased by seasonal sampling and that contains a measure of precision.
- More informed decision making based on our evaluation of ground-based hunting and trapping of wolves as a predation control method.
- A description of the characteristics of wolf populations that are hunted and trapped and how those populations differ from naturally-regulated populations in terms of social structure, reproductive performance, and predation rates.
- Improved performance in computer models used by managers to predict the consequences of management actions on wolves and their prey.
- Broader public acceptance of the Department of Fish and Game's management of wolves and their prey.

STUDY APPROACH

General Approach

Wolf predation rates on moose and caribou will be estimated using a periodic sampling design in which 9 radiocollared wolf packs are monitored during eleven 4-day random intervals during winter. Where possible we will examine the effects of several covariates on kill rate including pack size, pack composition, prey distribution, prey abundance, prey species, prey sex, prey age, snow depth, temperature, and season. Existing data on characteristics of wolf populations that are regulated by hunting and trapping will then be combined with the

predation rate data to develop predictions for the effectiveness of hunting and trapping in both regulating wolf numbers and reducing wolf predation on moose and caribou.

JOB OBJECTIVES AND PROCEDURES

Job 1 Capture and radiocollar approximately 9 wolves in 9 different packs in the Alaska Range foothills in Unit 20A. In early May 2000, there were 8 potential study packs containing radiocollared animals on the north side of the Alaska Range in Unit 20A. Those animals were collared between 1996 and 2000 as part of a study investigating the effects of intensive trapping on wolf population dynamics. All of the collared animals are associated with packs. Two animals were collared in 7 packs, and 1 animal was collared in the eighth pack. Before we begin the kill rate study, additional collars need to be deployed in packs where we expect existing collars to fail, or the collared wolves to disperse. In addition, we need to find and deploy collars on single animals or pairs to allow us to sample kill rates of singles and pairs.

Job 2 Estimate wolf predation on moose and caribou by monitoring wolf activities during eleven 4-day aerial surveys conducted between October and April. The winter period between 15 October and 15 March will be divided into eleven 2-week periods. Within each period, a random starting date will be selected and beginning on each of the 11 random starting dates we will locate all of the 9 study packs for 4 consecutive days. On the first day each pack will be located and we will determine whether the pack is on a kill. On subsequent days each pack will be located and then backtracked, by following tracks in the snow, to the previous day's location. Kills made by each pack between the first and fourth location of each sample period will be recorded. If wolves are on a kill when located on day 1, that kill will not be included in the calculation of kill rates because the date of the kill is unknown.

Job 3 Visit kill sites of moose and caribou via helicopter to determine age, sex and condition of prey killed by wolves. The physical condition and age of prey individuals likely contribute to their selection as prey by wolves. For each kill found during the sampling periods, we will later visit the kill site and collect marrow samples, incisors for aging, and wolf scats. Kill sites will be accessed via helicopter at the end of every even numbered sampling period. Marrow samples will be dried to estimate % fat, teeth will be sent to Matson's Laboratory for aging, and wolf scats will be shipped to Big Sky Laboratory in Florence Montana for analysis.

Job 4 Monitor distribution of moose and caribou within the kill rate study area. Selection of prey types by different wolf packs will be related to the distribution of prey types within the study area. Currently, approximately 80 caribou are radiocollared in the Delta caribou herd. Many of those caribou spend portions of the winter on the north side of the Alaska Range, but they move frequently as they forage. On the first day of each 4-day sampling period we will locate the radiocollared caribou that are within the boundaries of the kill rate study area. Using the proportion of radios within vs. outside the study area, we can estimate the number of caribou within the study area and the number of caribou within each of the individual pack territories.

Moose distribution and abundance will be estimated by stratification and composition surveys. We believe that moose distribution remains relatively constant throughout winter. However, to test that hypothesis, we will conduct moose stratification surveys 3 times during the winter, in early November, early February and late March.

Job 5 Purchase wolf carcasses from private trappers who take wolves within the study area. Wolf carcasses will be examined for reproductive history, body condition, and age. Sex and age composition of some study packs can be determined by combining our knowledge of the sex and age of marked animals and of unmarked animals obtained from trappers. Sex and age composition of packs may affect kill rates.

Job 6 Estimate the proportion of snowshoe hares in the wolf diet. Snowshoe hares in Interior Alaska will reach their 10-year peak during winter 2000–2001. Hares will be abundant within the study area and may be a significant food for wolves. To estimate the frequency of hares in the winter wolf diet, we will collect scats at kill sites and on trails not associated with kill sites.

Job 7 Fly aerial surveys to estimate the wolf population within the study area. Wolf numbers within the study area will be determined by a combination of counts obtained from animals associated with radiocollared wolves, and animals that are not associated with radiocollared animals. During autumn, shortly after a fresh snowfall, we will count the wolves not associated with radio collars by following their tracks in the snow. Simultaneously we will locate all radiocollared animals so we can separate marked packs or individuals from unmarked packs or individuals.

Job 8 Complete data analysis and write reports integrating information on the effects of human harvest on wolves with information on predation rates on moose and caribou by wolves. Data collected between 1993 and 1999 on the effects of wolf harvest on wolf population structure and change will be analyzed and reported. Information collected during the kill rate study will then be integrated with the wolf population data to develop an analysis of wolf-prey-human interactions in Unit 20A.

Job 9 The principal investigator will present the results of this study at agency workshops, agency meetings or scientific conferences related to the management of northern wolf-prey systems.

COOPERATORS

None.

GEOGRAPHIC LOCATION

Study Area: Unit 20A, core study area will be in the foothills on the north side of the Alaska Range.

RELATED PROJECTS

- Caribou, moose, sheep and bear research and management in Unit 20A and Unit 13.
- Caribou and wolf research in Denali National Park.
- Caribou and wolf research in Yukon Territory conducted by Yukon Department of Renewable Resources.

REPORTING SCHEDULE

Progress reports will be in headquarters by 1 September 2001 and 2002. Final report will be in Headquarters by 1 September 2003.